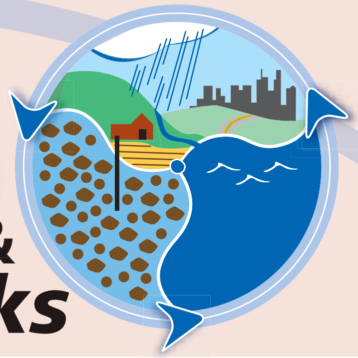
Ground Water & Underground Storage Tanks



Underground storage tank (UST) systems that contain fuels, chemicals, and wastes are numerous and widespread and pose a significant threat to ground water quality in the United States. Currently, there are more than 640,000 federally regulated active USTs that store fuels or hazardous substances. These systems can and do leak, and when they leak they contaminate soil and ground water—even hydrologically connected surface water. These leaks often occur in populated areas, where public and domestic water supplies are concentrated, and it is difficult and expensive to clean them up, particularly if they involve a public source of drinking water.

Key Message

Since 1985, federal and state UST programs have significantly reduced the risk of new releases by implementing release-prevention and leak-detection requirements and establishing improved design, installation, and operational technical standards. Federal and state leaking underground storage tank (LUST) programs have overseen the cleanup of nearly 351,000 leaking tank sites. At the same time, states have had to respond to new contamination problems from fuel constituents such as methyl *tert*-butyl ether (MTBE). The continued widespread use of UST systems (including large numbers of heating-fuel storage tanks that are not federally regulated) requires that existing regulations be fully enforced and that additional regulatory, land-use, and engineering measures be developed and fully implemented to further minimize threats to public health and safety, the economy, and the environment.

Photo: Missouri PSTIF

A leaking underground storage tank is removed from gasoline-contaminated ground water.

When Buried Fuel Storage Tanks Leak

> "*We appreciate that the initial cause of the leak was a freak accident…and that someone was well aware of the losses that went unreported to the Maryland Department of Environment for over a month. We know what the impact has been on our community. We also know that we will all be living with this travesty and its lingering consequences for years to come*"

Glenn A. Thomas | The Greater Jacksonville Association, Inc | *LUSTLine,* February 2007

why Underground Storage Tanks matter to ground water…

The majority of USTs contain petroleum products such as gasoline, diesel fuel, heating oil, kerosene, and jet fuel. In addition, substances classified as hazardous by the Resource Conservation and Recovery Act and the Comprehensive Environmental Response, Compensation, and Liability Act ("Superfund") are also stored in USTs—USEPA estimates that about 25,000 hold hazardous substances covered by the federal UST regulations. (USEPA, 2007)

Besides the 640,000 federally regulated USTs in operation nationwide (USEPA, 2007), there are millions more federally exempt tanks, such as heating-oil tanks and aboveground storage tanks (ASTs). The good news is that over the past 20 years, more than 1.6 million substandard tanks have been properly closed and are no longer in use (USEPA, 2007). But USTs and ASTs continue to be a concern because each installation has the potential to leak, threatening human health and the environment. Leaked product contaminates ground water used for drinking and other uses and, on occasion, enters surface water.

Of the federally regulated petroleum storage tanks, as of September 2006, there were about 465,000 con-

Photo: Missouri PSTIF

Gasoline-contaminated ground water visible after the removal of a UST indicates that there has been a release from somewhere in the UST system (e.g., piping, tank, joints, spill buckets).

SUBSURFACE VIEW OF AN UNDERGROUND STORAGE TANK SYSTEM PRODUCT RELEASE

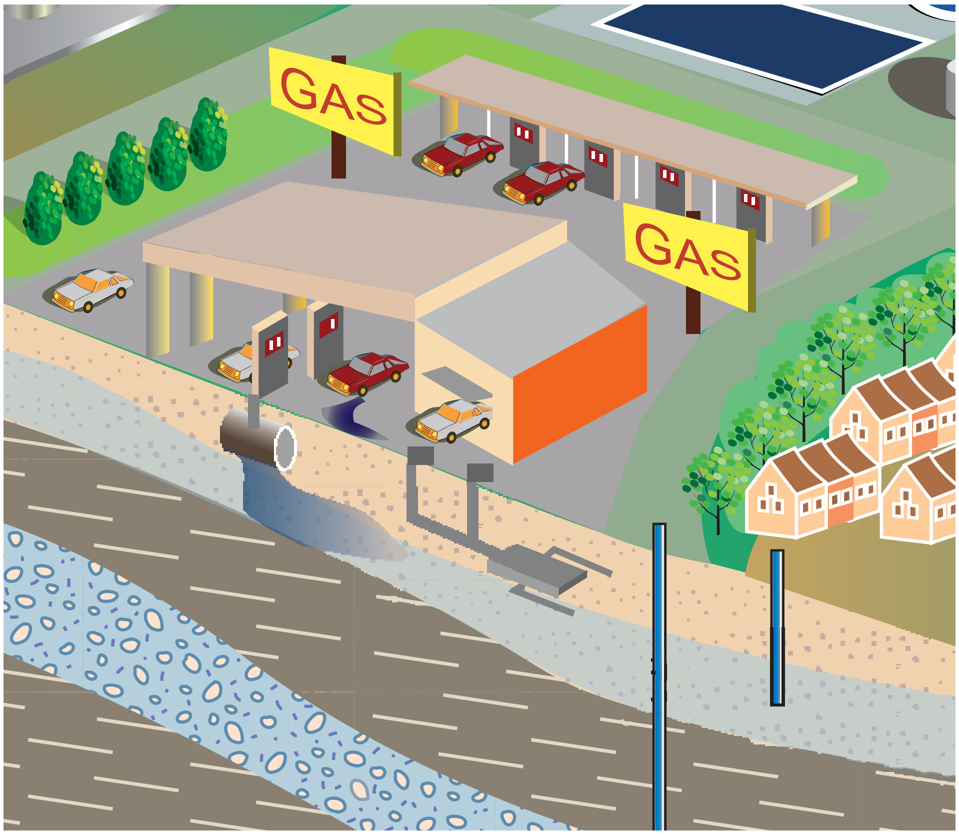


Figure 1. *When gasoline leaks from a failed UST system, it moves from the backfill surrounding the tank or piping into the native soil and into ground water; volatile vapors often move upward into and around buildings and infrastructure. Over time, some of the leaked product either floats on top of the ground water table or dissolves into the ground water, where it moves downgradient with the ground water. If there are drinking water wells nearby, the leaked product can be drawn into the wellhead area.*

firmed releases (leaks) and 436,000 cleanups initiated, of which 351,000 had been completed (USEPA, 2007). However, cleanup efforts haven't even begun for more than 32,000 sites, many comprising what are considered to be abandoned tanks with no identified responsible party (USGAO, 2005). Many forgotten buried steel tanks have yet to be discovered that may still contain product or have leaked.

Given our dependence on internal-combustion engines, we'll continue to rely heavily on USTs to store our motor fuels, as well as other harmful substances. Today's improved UST systems are the product of federal and state requirements and programs, as well as improved technologies and a heightened awareness on the part of tank owners and operators. However, leaks still occur, albeit far less frequently, and we must stay vigilant in order to prevent tank systems from leaking in the first place and to ensure that leaking systems are reported immediately and cleaned up expeditiously.

UNDERGROUND STORAGE TANKS IN THE NATURAL SYSTEM

Most older petroleum UST sites have some contamination. The main chemicals of concern in gasoline are benzene, toluene, ethylbenzene, and xylenes (BTEX). Benzene, a known carcinogen, is the most hazardous

Petroleum product from a LUST that contaminated ground water and then impacted surface water. The white areas are absorbent materials used for soaking up the hydrocarbons in the water.

LOCATIONS OF USTs AND PUBLIC WATER SUPPLY (PWS) WELLHEADS

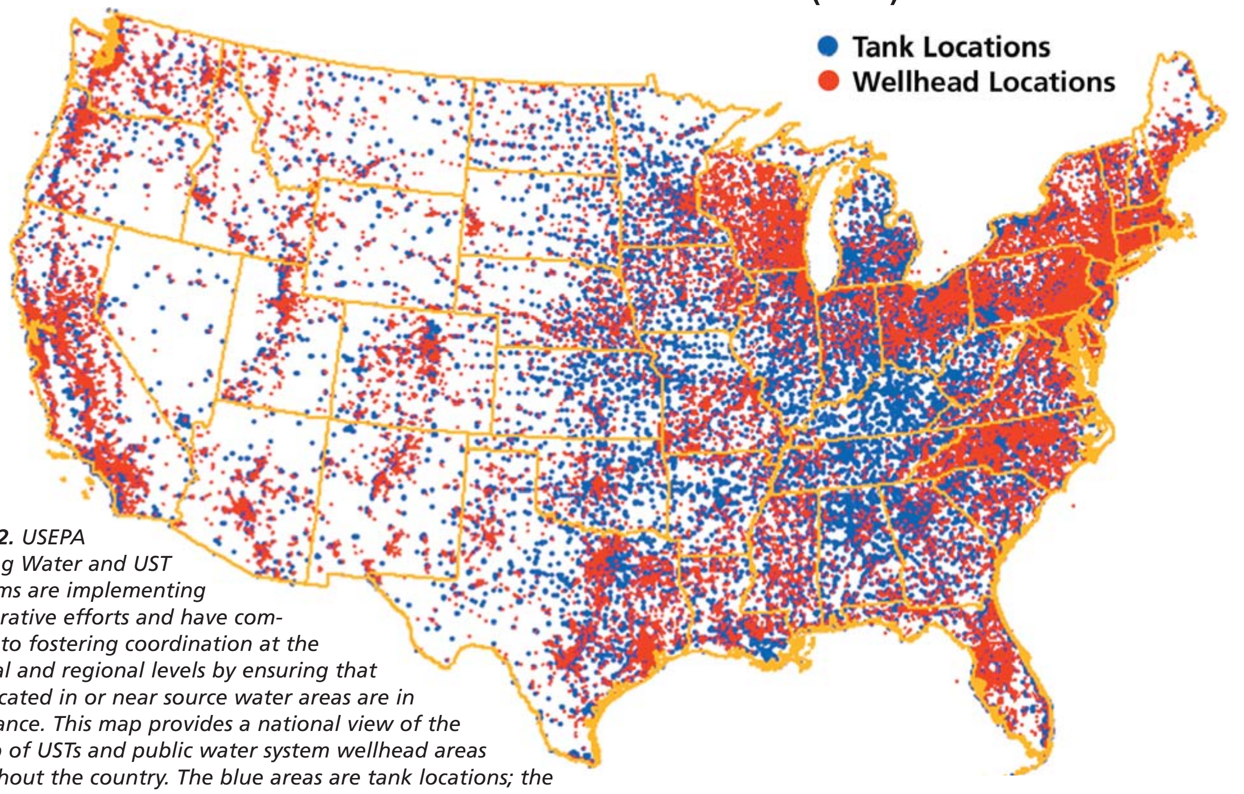


Figure 2. *USEPA Drinking Water and UST Programs are implementing collaborative efforts and have committed to fostering coordination at the national and regional levels by ensuring that USTs located in or near source water areas are in compliance. This map provides a national view of the overlap of USTs and public water system wellhead areas throughout the country. The blue areas are tank locations; the red areas are wellhead locations. http://www.epa.gov/oust/swanust.htm Source: USEPA*

of these compounds. When gasoline leaks from a failed UST system, it moves from the backfill surrounding the tank or piping into the native soil and into ground water; volatile vapors often move upward into and around buildings and infrastructure. The fate and transport of gasoline in the environment is complex and depends on a number of local physical, chemical, and biological factors.

Over time, some of the leaked product either floats on top of the ground water table surface or dissolves into the ground water, where it moves downgradient with the ground water. Some of the product may also become trapped in the soil pores, evaporate upward through the soil, or cling to soil particles. Petroleum product held in the soil is released slowly over time.

It doesn't take much gasoline to contaminate drinking water. A spill of 10 gallons of gasoline contains about 230 grams of benzene. USEPA's Maximum Contaminant Level (MCL) for benzene is 5 parts per billion (ppb), or 5 micrograms per liter, in drinking water. The density of gasoline is about 0.8 grams per milliliter, so the benzene in a 10-gallon gasoline leak can contaminate about 46 million liters—or 12 million gallons—of water! *(http://bcn.boulder.co.us/basin/waterworks/lust.html)*

SERIOUS BUSINESS

Burying a tank that holds a hazardous substance is serious business. But we haven't always looked at it that way. In the past, once a tank was buried, it was out of sight and out of mind. Most tank owners didn't think much about their tank systems, and only large losses of inventory prompted a check for leaks. In 1984, there were more than 2.1 million buried tanks, many of which were leaking and contaminating

A bailer pulled from a LUST-site monitoring well shows that about a foot of free-product gasoline is present in the ground water.

SOURCES OF UST RELEASES

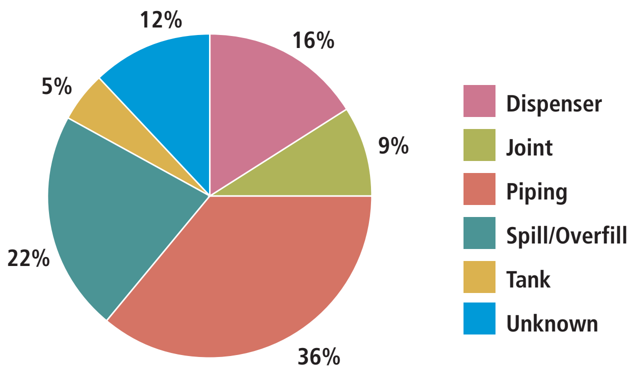


Figure 3. Based on the Missouri Petroleum Storage Tank Insurance Fund data from 76 releases, where there was an "identifiable release" from an operating UST system.

Source: Missouri PSTIF.

ground water. (USEPA, 2001) The majority of these were of single-walled, bare-steel construction—and highly susceptible to corrosion. To make matters worse, tanks were located without regard to their proximity to drinking water supplies.

UST releases are not limited to the tanks; leaks can be associated with any component of the storage system—piping, fittings, dispensers, sumps, vapor recovery. In fact, piping continues to be the number-one culprit in system failure. UST system failures can be the result of corrosion, structural deficiencies, improper installation, and/or loose fittings. Product delivery overfills and spills are another key source of contamination. (See Figure 3.)

Rules to the Rescue

In 1983, the CBS program *60 Minutes* aired a story called "Check the Water," which brought national attention to the problem of leaking underground storage tanks. In 1984, Congress passed the Subtitle I RCRA Amendments, directing USEPA to establish programs and regulations to prevent, detect, and clean up releases from petroleum or hazardous substance UST systems. The USEPA UST regulations used, in part, regulations already in effect in some states.

The federal rules, promulgated in 1988, triggered a sea change in the UST universe. Every phase of the life cycle of the storage system was addressed—design, construction, and installation of new systems; upgrading of existing systems; operation and maintenance; release cleanup; and closure. The UST rules set forth minimum federal standards and phased-in deadlines for leak detection, corrosion protection for both tanks and piping, and spill and overfill prevention. Owners and operators of existing tanks were given until 1998 to upgrade, remove, or replace substandard tanks. All releases had to be reported to the proper authority.

Because of the large tank universe, and the existence of some state regulations, USEPA designed the UST program to be implemented by the states. With the new federal regulations in hand, states were tasked to develop their own programs and seek federal program approval, which hinged on having adequate funding for their program and staff, regulations that were at least equivalent to federal regulations, adequate enforcement capabilities, and the capacity and willingness to carry out the program. As of August 2006, 35 states, plus the District of Columbia and Puerto Rico, had approved programs. (USEPA, 2007)

Photo: Pepijn Schmitz - http://www.flickr.com/photos/captainchaos/40136212/

This gas station from the Route 66 heyday is emblematic of many such facilities that are now abandoned along former busy highways. UST programs in many states are trying to address these sites in order to remove tanks that may have been leaking for years and facilitate necessary cleanups.

THE VERY ESSENTIAL UST/DRINKING WATER CONNECTION

The opportunity for cross-program integration couldn't be more obvious and necessary than in the realm of federal and state drinking water and UST programs. Given that more than half of the people in the United States rely on ground water for their drinking water and that contamination from LUSTs is a widespread threat to ground water sources, it makes a whole lot of sense for these programs to work together to maximize their effectiveness in protecting ground water sources.

While many state UST/LUST and drinking water programs have been working together for many years, it took a national initiative to really draw attention to the need for an interprogram communication process. In 2004, the USEPA Office of Underground Storage Tanks (OUST) made a commitment to protect drinking water by cosigning two memos with the USEPA Office of Ground Water and Drinking Water and holding collaborative state and regional meetings on the subject. Both memos are available on the OUST website *(http://epa.gov/oust/swanust.htm)*. They contain several tips for states interested in working with their drinking water program.

The state source water assessments (see Section 4 – "Ground Water and Source Water Protection") are a great place to begin this collaborative process. These assessments show, among other things, sources of drinking water most at risk for contamination from USTs. Drinking water programs, water suppliers, and local governments have this information or can create it from geographic information system (GIS) layers. Many state tank and drinking water programs are already actively sharing information through their GIS databases. These programs can be partners in preventing releases in source water areas and ensuring that releases that do occur are prevented from impacting drinking water supplies.

For example, as with many states, Massachusetts and Arkansas UST and drinking water programs are located in different agencies, yet they work together to prioritize UST inspections in source protection areas. Illinois recently passed a regulatory amendment requiring the identification of potable water wells in relation to LUST cleanup sites. The Louisiana Department of Environmental Quality has created a two-page fact sheet titled Best Management Practices for Underground Storage Tanks to Prevent Drinking Water Contamination, which is distributed by local parishes to UST owners/operators *(http://www.deq.louisiana.gov/)*.

Source: Kara Sergeant. February 2007. "A Marriage Made in Groundwater: How State UST, LUST, and Source Water Programs Can Work Together to Protect Drinking Water." LUSTLine, Bulletin 54. New England Interstate Water Pollution Control Commission.

Photo: USGS

Direct-push technology has allowed for more time-sensitive and effective field investigations at LUST sites. In this photograph, direct push is being used to investigate the discharge of MTBE-contaminated ground water into a surface-water body.

Cleaning Up

Ground water cleanup programs have come a long way since the 1980s. By today's standards, early cleanups were crude and protracted. Since then, many effective cleanup options have emerged. LUST cleanup often involves combinations of technologies, including monitored natural attenuation and a risk-based cleanup option. More careful siting of new USTs has also helped reduce future risk.

Accurate site characterization is critical to the development of an effective cleanup strategy. Hydrogeologists must determine the appropriate number and location of wells so that information retrieved is repre-

DISTANCING USTS FROM DRINKING WATER SOURCES

MAINE'S UST SITING LAW

Besides enforcing federal, state, and local UST program requirements, there is another highly effective way to ensure that the contents of underground and aboveground storage tanks do not contaminate drinking water sources—keep them away from those sources.

In 2001, the State of Maine passed the Act to Protect Sensitive Geologic Areas from Oil Contamination, which prohibits or modifies the installation of UST facilities in proximity to existing water supplies (public and private wells) and future water supplies (significant sand and gravel aquifers). The requirements apply only to motor fuel and bulk plant USTs, not to the expansion of USTs that existed at a site prior to the implementation date.

Under the law, tanks cannot be installed:

- Within 300 feet of a private well, other than the well used to supply water to the business with the UST.
- Within 1,000 feet (or within the source water protection area, whichever is larger) of a community water supply (e.g., municipal well, mobile home park well, condominium) or a school well.
- Over a high-yield (more than 50 gallons per minute) sand and gravel aquifer.
- Within 1,000 feet (or within the source water protection area, which ever is greater) of a transient (e.g., restaurant, highway rest stop) or non-transient (e.g., school, office park) public water supply.
- Over a mapped moderate-yield (between 10 and 50 gallons per minute) sand and gravel aquifer.

Photo: Scott Ruth, P.G. Bristol Environmental & Engineering Services Corp.

Arizona's Gila River Indian Community, along with USEPA, installed and activated this LUST site cleanup system to remediate hydrocarbon-contaminated soil and ground water. In what is expected to culminate in a 10-year cleanup effort, the final price tag may exceed $2 million.

sentative of what is happening in the subsurface. Portable direct-push technologies have allowed consultants to go out to a site, collect many samples, and obtain real-time results. With this initial information, monitoring wells can then be installed where they need to be and modeling can be used to predict plume behavior.

Risk-Based Cleanups

Besides the benefit of experience, cost has been a major driver in improving LUST investigation techniques. One of the most significant changes in LUST cleanup approaches has been the use of risk-based decision making. The process involves evaluating all aspects of a site and determining how much leaked fuel can "safely" be left in the ground, rather than trying to clean up a site to a one-size-fits-all predetermined cleanup number, such as an MCL.

Today, many sites are closed leaving some amount of product in the ground, with ongoing monitoring to validate the attenuation process. This process is dependent on a determination that receptors, such as homes or businesses, will not be impacted. Given the possibility that

As a UST is removed, gasoline released from the UST system becomes apparent in the tank pit. Discovering the contamination is only the beginning of a long and expensive process that includes site investigation, cleanup, monitoring, and often litigation.

new receptors could enter the picture in future development proposals, these sites are often closed with some kind of institutional control attached, such as a deed restriction.

Paying for LUST Cleanups

Paying for LUST cleanups, which can range from $100,000 to more than $1 million is a serious issue. A February 2007 report from the U.S. Government Accountability Office (USGAO) says it will cost at least $12 billion in state and federal funds to clean up known releases of gasoline and other hazardous substances from leaking underground storage tanks nationwide. USGAO estimates that EPA and the states have paid out more than $10 billion to clean up underground tank releases over the past 20 years.

To ensure they will be able to pay for remediation work, the federal Resource Conservation and Recovery Act requires UST owners and operators to demonstrate financial responsibility (FR) by obtaining some form of insurance or financial coverage for cleanup costs and third-party compensation for bodily injury and property damage caused by LUSTs. However, USGAO found that most states do not check regularly to see if coverage is current.

Most states have established financial assurance funds—capitalized through such devices as per-gallon or per-barrel fees on gasoline coming into the state—an important means for owners and operators to demonstrate FR. According to the 2007 Vermont State Funds Survey, 37 states have fully functioning funds, nine have transitioned to private insurance, three do not have funds, and one is being reestablished. During 2006, state funds paid out about $1 billion for LUST cleanups. As of May 2007, state fund programs had paid out a total of $15,453 billion. Yet, as USGAO noted, some state financial assurance funds are not sufficient to ensure timely cleanup work.

In the event of a release, tank owners covered by state financial assurance funds usually pay a relatively small deductible, while the funds can provide large sums of public financing to complete the required cleanup. Because the deductibles are small, USGAO noted that there might not be a sufficient incentive for tank owners to prevent releases from occurring.

The federal LUST Trust Fund, created by Congress under the 1986 RCRA Subtitle I Amendments, provides money for overseeing and enforcing corrective action by a responsible party and for cleaning up abandoned tanks whose owners are unknown, unwilling, or unable to pay for cleanup. This fund is capitalized by a by a federal tax on gasoline of one-tenth of a cent per gallon. According to USGAO, the account had an unspent balance of $2.5 billion at the end of fiscal 2005. The surplus is expected to reach $3 billion by the end of fiscal 2008. Yet, USGAO noted, in fiscal year 2005, EPA distributed only $58 million to the states from the Fund.

WE'VE COME A LONG WAY

National attention to USTs has paid off. Most UST systems are now equipped with automatic tank gauges that monitor fuel levels and print out reports and sound alarms when a release is suspected. Steel tanks are required to have corrosion protection and/or reinforced-plastic jackets. Many states have adopted programs to ensure that UST systems are installed properly. By the 1998 deadline, which required UST owners/operators to upgrade, replace, or remove tanks, approximately 80 percent of the nation's tanks systems were in compliance, and that number has continued to rise. Several states went further by requiring double-walled tanks and piping. Many tank owners have independently made the move to double-walled fiberglass or steel systems.

Unfinished Business

In March 2003, USGAO reported that "89 percent of the 693,107 tanks subject to UST rules had leak-detection and -prevention equipment installed, but that more than 200,000 tanks were not being operated and maintained properly, increasing the chance of leaks." The report was undertaken in response to concerns expressed by members of Congress that the UST program was not effectively preventing leaks and that USTs continued to pose risks. Too many tank owners and operators are not familiar with state or federal requirements and need more training on how to operate and maintain their systems properly.

The majority of states have UST facility inspection backlogs; until very recently, some facilities hadn't been inspected since the 1998 upgrade deadline. Even though any suspected leak is supposed to be reported immediately, states often only find evidence that there may be a leaking system during a compliance inspection or an off-site impact such as a drinking water well. Many states are strapped for resources to effectively carry out inspection programs. Thus, even well-meaning tank owners and operators who think they are in compliance may have a tank system that is an accident waiting to happen—a situation that could be remedied by a visit from an inspector.

Some states have documented extensive problems with plastic flexible-piping systems introduced in the early 1990s to avoid problems with leaking unions and joints. Use of this piping is widespread and concerns continue. Also, spill buckets and under-dispenser sumps, which were not adequately addressed in the federal rules, have emerged as major sources of leaks.

The Concern over MTBE

Just when state UST programs were getting proficient at managing the cleanup of petroleum hydrocarbons, along came the gasoline additive methyl *tert*-butyl ether (MTBE), a monkey wrench in LUST cleanup programs. MTBE is an oxygenate that has been widely added to gasoline, first as an octane enhancer and later so that the gasoline would comply with reformulated gasoline (RFG) requirements of the 1990 Clean Air Act Amendments.

The unintended consequence of using MTBE to fix one environmental problem has led to another. MTBE has been detected at low levels in ground water in locations nationwide and at elevated levels in some public and private water supplies. MTBE is classified as a potential human carcinogen, but as yet, EPA has no MCL. In December 1997, EPA issued a Drinking Water Advisory of 20 to 40 parts per billion, based on taste and odor thresholds, to assist drinking water suppliers and LUST programs in making decisions about "acceptable" MTBE levels. Many states have adopted their own standards.

MTBE is very soluble and, once released, moves through soil and into ground water more rapidly than other chemical compounds present in gasoline. Once in ground water it is very persistent. The MTBE conundrum has given state programs pause about potential ground water contamination threats or issues associated with other gasoline constituents, such as ethanol, *tertiary*-butyl alcohol (TBA), *tert*-amyl methyl ether (TAME) and ethylene

A new UST system is being installed. Leak prevention depends on the proper installation of a UST system that meets regulatory standards. This system must then be properly operated and maintained.

dibromide (EDB). For example, recent studies have shown that when ethanol is in a gasoline release, microorganisms prefer to feed on (degrade) the ethanol, causing the BTEX component to move farther, reducing its rate of natural biodegradation. (Mackay et al., 2006)

The Energy Policy Act

Title XV of the Energy Policy Act of 2005 created the Underground Storage Tank Act of 2005, which amends the original legislation that created the federal UST program. The Act addresses some of the pressing issues in the federal/state UST programs, including:

- Requiring secondary containment for new and replaced tanks and piping, or financial responsibility for tank installers and manufacturers.
- Inspecting tanks every three years.
- Prohibiting fuel deliveries at noncompliant UST facilities.
- Developing operator-training requirements.
- Cleaning up releases that contain oxygenated fuel additives.

The deadlines, however, are very tight, and the funding to accomplish these tasks, though authorized in the Act, may not get to the states until FY2008. The states are working on meeting these requirements under severe funding constraints.

The Act also made several alterations to the Clean Air Act RFG program, including removal of the 2 percent oxygenate mandate for RFG. In response to the law, USEPA promulgated a direct final rule to amend the RFG regulations in order to eliminate regulatory standards requiring the use of oxygenates (e.g., MTBE) in RFG.

MINIMIZING THREATS FROM USTS AT THE LOCAL LEVEL

Besides state requirements and statutes, there are a number of actions municipalities can take to minimize threats to their water supply sources from underground and aboveground storage tanks. These include:

- Establish a comprehensive program to prevent the contamination of present and future drinking water from fuel storage tank releases.
- Take advantage of readily available GIS map resources to inventory all storage tanks in your source protection area.
- Make a special effort to locate and remove or properly close all abandoned tanks.
- Contact your state UST program to find out:
  - which UST facilities in your community's source protection area are in the state regulatory database
  - when those facilities were last inspected
  - facility compliance records
  - how you can work with the state to address facilities of concern
- Develop municipal ordinances, overlay zones, best management practices, or regulations to address potential threats from petroleum storage tanks in your source water protection area. (NEIWPCC, 2004)

Photo: Steve Minor

A modern gas station in western New Mexico.

Recommended Actions

To Congress:

- Appropriate LUST Trust Fund money so that it can be sufficiently used for the purposes intended by Congress.
- Appropriate the funds necessary for states to carry out the new measures of the Energy Policy Act.
- Appropriate LUST Trust Fund money to the states for implementing the UST provisions of the Energy Policy Act (i.e., inspections, enforcement).
- Reevaluate the feasibility of including tank systems not currently covered by federal UST regulations, such as heating oil tanks and aboveground storage tanks not covered by Spill Prevention Control and Countermeasures rules.

To USEPA:

- Continue to encourage states to target UST enforcement and LUST response activities in areas of high-priority ground water (e.g., wellhead protection areas); over significant or single-source aquifers; near springs, sinkhole areas, and other karstic features; and in proximity to private wells.
- Modify the current UST regulations (40 CFR 280) so that standards meet today's technological capabilities.

To State Agencies:

- Adopt siting requirements for new UST facilities, including the establishment of minimum setback requirements in relation to water supply wells and high-priority ground water areas, and more protective requirements for existing tanks in high-priority ground water areas (e.g., site-grading requirements to keep storm water away from fueling areas).
- Prioritize UST inspections, compliance, and enforcement efforts for facilities within source water areas, near private drinking water wells, and over high-priority aquifers.

Leaks still occur, albeit far less frequently, and we must stay vigilant in order to prevent tank systems from leaking in the first place and to ensure that leaking systems are reported immediately and cleaned up expeditiously.

Photo: Missouri PSTIF

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Photo: Dave Belyea

This biofuels station in Eugene, Oregon, takes the whole business of fuel dispensing to a new level. Sited where a former gas station left behind petroleum-contaminated soil and ground water, the station is also a successful brownfield venture. It offers an assortment of biofuel blends for all gasoline and diesel vehicles, has a state-of-the-art double-walled fuel-storage system, is powered by 100% renewal energy, is bordered with grassy bioswales for stormwater runoff control, and has a "living roof" on the convenience store to reduce the flow of stormwater from what would otherwise be an impervious surface.